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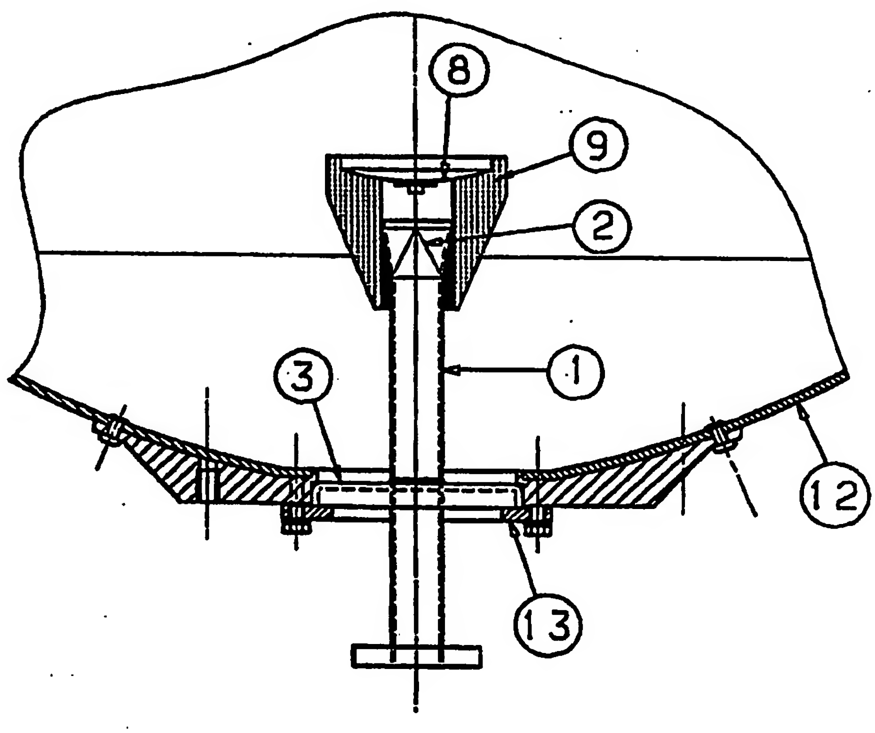
(54) Title: MANUFACTURING PROCESS FOR A DOUBLE-REFLECTOR ANTENNA ILLUMINATION SYSTEM WITH AXIAL LENS SUPPORT AND ASSOCIATED ILLUMINATION SYSTEM

(57) Abstract

The manufacturing process has the following steps: the terminal part of a waveguide section (1) is processed by a controlled cold deformation process to achieve a radiant opening (2); by means of a positioning template there is fixed to the radiant opening a rigid support (9) with low loss and dielectric constant near the air and to which is in turn fixed a sub-reflector (8), the entirety constituting the illumination system; and the illumination system is then assembled in the apex of the antenna.



"Manufacturing process for a double-reflector antenna illumination system with axial lens support and associated illumination system"

* * * * *

DESCRIPTION

The present invention relates to the field of double-reflector antennas and specifically to a manufacturing process for a double-reflector antenna illumination system with axial lens support and to the associated illumination system thus achieved.

In the implementation of double-reflector antenna systems an important problem to be solved is simplification of the production process to achieve a significant mass production cost reduction without sacrificing the electrical characteristics even in the case of crossed polarization signal.

Another problem is achieving an antenna system easy to install and repair, i.e. allowing operation with the greatest ease and safety in the steps of installation and repair in the field.

Another problem is the implementation of a system allowing completion as much as possible of the operations of setting and adjustment, especially those of centering and alignment of the illumination system, not during installation on site but during production, and allowing easy access to the various parts for any problems of repair in the field.

No antenna systems having a double-reflector illumination system with axial lens support and solving at once all the above mentioned problems are known.

Accordingly the purpose of the present invention is to solve the above mentioned technical problems and indicate a manufacturing process for a double-reflector illumination system with axial lens support in which the illumination system is provided in a very compact manner with a wave guide section terminating with a circular radiating aperture on which is fixed in a projecting manner a support of appropriate dielectric material, which in turn supports in a projecting manner a secondary reflector. The entire assembly is then fixed in the apex of the primary reflector from the rear thereof and with a flange welded to the guide section to achieve a very compact antenna system easy to produce, having low cost, and on which it is very easy to perform maintenance.

To achieve these purposes the present invention has for its subject matter a manufacturing process for a double-reflector illumination system with axial lens support as better described in claims 1 to 7.

Further subject matter of the present invention is a double-reflector antenna

illumination system with axial lens support as better described in claims 8 to 12.

The advantages of the present invention are evidently the following:

- provision of the illuminator aperture by means of a controlled cold deformation process with low cost and easily applied in mass production and which uses both a buffer and an external counter-die in such a manner as to guide the resulting deformation;
- provision of an illuminator & secondary reflector (sub-reflector) system in a single block with optical & electromagnetic alignment, achieved during manufacturing to eliminate the problems of centering and alignment, otherwise remaining to be performed during installation at site;
- achievement of symmetrical radiation diagrams especially in the first secondary lobe area where the greatest radiated power is contained;
- freedom to intervene on said lens system on site while working safely from the rear of the antenna without then removing either all of the antenna or part thereof, such as in some cases the protective window which closes the front of the antenna aperture.

Further purposes and advantages of the present invention are clarified in the detailed description of an embodiment thereof given below by way of nonlimiting example with reference to the annexed drawings wherein:

FIG. 1 shows a schematic drawing of the antenna-integrated illumination system which is the object of the present invention,

FIG. 2 shows the method for achieving an aperture with a circular cross section 2 constituting the terminal part of a section of wave guide 1 forming part of the illumination system which is the object of the present invention, and

FIG. 3 shows in greater detail part of the illumination system which is the object of the present invention in relation to the fastening of the secondary reflector.

With reference to FIG. 1 the antenna illumination system which is the object of the present invention is essentially made up of:

a) a primary illuminator provided by:

- a section of wave guide 1 of a length dependent upon the geometrical characteristics of the primary reflector and the secondary reflector and having a cross section of a shape dependent upon the type of signal to be transmitted and typically rectangular (single-polarization illuminator) or circular (double-polarization illuminator) but not excluding the possibility of using other forms such as elliptical or square, and
- an aperture of circular cross-section 2 constituting the emitting and/or receiving terminal part of the wave guide 1 and having a diameter corresponding to

that of the best polarization discrimination condition for circular apertures, found experimentally through measurements in an anechoic chamber with methods known to those skilled in the art;

b) a sub-reflector 8 convex in form and supported by a rigid support 9 of material having low loss and relative constant dielectric near that of air and which in turn is fixed in a projecting manner on the terminal part of the section of wave guide 1 comprising said circular cross section aperture 2, in such a manner that the sub-reflector 8 is aligned axially with said section of wave guide 1 with the convex part in front of the circular aperture 2 at an appropriate distance therefrom determined by the optical & physical design of the antenna;

c) a flange 3, e.g. in disk form, even though other forms are also possible, fixed to the wave guide section 1 in an appropriate position and which couples with a primary reflector 12 in the apex thereof and which allows supporting the illumination system and holding it rigidly in the position defined by the optical & physical design of the antenna.

There are now explained the steps of the manufacturing process of the antenna illumination system which is the object of the present invention and the subsequent installation of the system on the main reflector.

With reference to FIG. 2, after having constructed in accordance with well known techniques the wave guide section 1, one end of it is first machined by a cold deformation process controlled in such a manner as to create the radiant circular cross section aperture 2.

The deformation is achieved by the use of a punch 4 having a form in accordance with the required trend to achieve a gradual passage (transition 6) from the circular aperture cross section 2 to that of the wave guide 1 whether circular, rectangular of some other form.

To control the deformation of the wave guide section 1 and avoid eccentricity caused by uncontrolled elongation of the material toward the outside of the guide, especially in case of transition from rectangular to circular guide, which would damage the polarization insulation, the manufacturing process includes the use of a counter-die 5 which copies the desired trend of the external surface of the transition 6.

The punch 4 is forced into the wave guide to deform it while simultaneously holding the counter-die 5 until the transition 6 takes the form of the counter-die.

Construction of the illumination system is performed with a positioning template (not shown in the figures) which ensures the correct relative distance between the component elements and correct reproducibility of the positioning

process with very high accuracy which depends on the quality of the template.

With reference to FIG. 3 the rigid support 9 is previously machined on a lathe or milling machine to give it a form in accordance with a revolving truncated cone with internal through hole. Between its major base 7 and minor base 10 there is drilled a hole coaxial with the axis of the truncated cone and of a diameter such as to allow, during the construction step of alignment running of the aperture 2 of the primary illuminator within it.

The major base 7 is further machined in such a manner as to couple perfectly with the surface of the sub-reflector 8.

The rigid support 9 is then cemented both to the sub-reflector 8 and the primary illuminator in a position defined by the above mentioned positioning template. The cementing is the structural type using epoxy resins or other appropriate types such as to not introduce a significant refraction index attenuation and/or variation, especially in the reflection of the electromagnetic waves by the sub-reflector 8.

This type of cementing achieves an interface collar 11 which lies on the external surface of the primary illuminator to reproduce its trend and on the dielectric support 9 to fill the intermediate space.

By means of the same template, the flange 3 (FIG. 1) is then fixed to the wave guide section 1 e.g. by welding.

At this point the illumination system is achieved and is ready to be mounted on the primary reflector 12.

Through a hole made previously in the apex of the primary reflector 12 (FIG. 1) the illumination system is inserted in said hole from the rear of the reflector. The flange 3 is fixed to the primary reflector 12 against a stopper made on the edge of the hole, e.g. by means of a counter-flange 13, in turn rigidly connected to the rear part of the main reflector with screws.

This constitutes an advantage, as explained above, with the resulting enablement of replacing said illumination system on site by working in safety from the rear part of the antenna and without removing the entire antenna or part thereof such as e.g. the protective window which is present in some case to close the front of the antenna aperture.

The illumination system thus consists, in view of the above, of a single block uniting both the primary illuminator and the secondary reflector coaxially with the main reflector axis. There is thus achieved an antenna consisting of a reflector symmetrical with respect to the radiation axis coinciding with that of the double-reflector illumination system .

Variant embodiments on the non-limiting example described are possible without going beyond the scope of the invention.

In accordance with possible variants, the flange 3 could be of any shape, provided that it is adaptable to the construction form adopted for the housing seat of the flange in the rear part of the primary reflector 12 around the hole made in the apex.

In the case of a metallic primary reflector the flange housing is provided by machining or pressing of an element having a circular crown form which adapts and fastens to the rear part of the main reflector around a hole made in the apex, e.g. with screws.

In the case of a glass-fiber reinforced plastic primary reflector, this element is incorporated among the successive layers of glass-fiber during their manufacture.

In accordance with other possible variants, other forms of the rigid support 9 are possible in addition to that of hollow truncated cone described above, provided they allow rigid positioning of the sub-reflector 8 at a given distance from the circular aperture 2.

For example, its form could be virtually that of a hollow cylinder surrounding the entire wave guide section 1 of the circular aperture 2 up to the flange 3 and cemented then on the flange itself as well as possibly on the guide again.

In accordance with another variant the sub-reflector 8 can be convex in form and in this case the housing seat in the rigid support 9 would be appropriately modified.

CLAIMS

1. Manufacturing process for a double-reflector antenna illumination system with axial lens support, said illumination system comprising a sub-reflector (8) and a wave guide section (1) for reception and/or transmission of a signal from or to said secondary reflector, **characterized in that** it comprises the following steps:

- the terminal part of said wave guide section (1) is processed by a controlled cold deformation process to obtain a radiant aperture (2) with circular cross section;
- there is provided a rigid support (9) of low-loss and relative dielectric constant near that of air while giving it by machining a form designed to: include at least part of said wave guide section (1), allow fastening in a projecting manner on said illumination system, and support said sub-reflector (8); and
- through the use of a positioning template there is fixed to the wave guide section (1) a flange (3) to provide said axial support by subsequent anchoring of the illumination system in the apex of a primary antenna reflector (12), and said sub-reflector (8) is cemented to said rigid support (9) and the latter to said illumination system in mutual positions controlled by means of the dima.

2. Antenna illumination system manufacturing process in accordance with claim 1, characterized in that said rigid support (9) is formed as an at least partly hollow truncated cone, and in that, for said anchorage to said illumination system, in the hollow of said rigid support there is made to run said wave guide section (1) and said rigid support is fixed by cementing in the terminal part of said wave guide section comprising said circular cross-section radiant aperture (2).

3. Antenna illumination system manufacturing process in accordance with claim 1, characterized in that said rigid support (9) is formed as a hollow cylinder so as to contain said wave guide section (1) up to said flange (3), and in that for said anchorage to said illumination system, in the hollow of said rigid support is made to run said wave guide section (1), and said rigid support is fixed by cementing on said flange (3) as well as possibly again on said wave guide section (1).

4. Antenna illumination system manufacturing process in accordance with claim 1, characterized in that said controlled cold deformation process of said wave guide section (1) is achieved by the use of a punch (4) having a shape formed in accordance with the required development to achieve a transition (6) from said circular aperture cross section (2) to that of the wave guide (1), and that there is also used a counter-die (5) which copies the desired development of the external surface of the transition; and in that the punch (4) is forced into the wave guide to deform it while simultaneously holding the counter-die (5) until said transition (6) assumes the

form of the counter-die.

5. Antenna illumination system manufacturing process in accordance with claim 1, characterized in that for said anchorage of the illumination system in the apex of said primary reflector (12) of the antenna there is previously made a hole in the apex of the primary reflector (12), shaping its edges so as to include a stopper, and that the illumination system is inserted in said hole from the rear of the reflector so that said flange (3) engages with said stopper, fastening it rigidly thereto by means of a counter-flange (13).

6. Antenna illumination system manufacturing process in accordance with claim 5, characterized in that in the case of a metallic primary reflector, said edges shaped so as to include a stopper are provided by mechanical machining or pressing an element formed in a circular crown which adapts and is fixed rigidly to the rear part of the primary reflector around the hole made in the apex.

7. Antenna illumination system manufacturing process in accordance with claim 5, characterized in that in the case of a glass fiber reinforced plastic primary reflector, said edges shaped so as to include a stopper are provided by machining or molding of an element formed in a circular crown which is incorporated in the successive layers of glass fiber during manufacturing of the latter and around the hold made in the apex.

8. Antenna illumination system for a double-reflector antenna with axial lens support, **characterized in that** it consists of:

- a primary illuminator in turn consisting of a wave guide section (1), and a circular cross section aperture (2) constituting the transmitting and/or receiving terminal part of the wave guide section (1) with said guide section having a cross section zone toward said terminal part whose form follows a transition (6) from the normal one of the guide section to that of the circular aperture:

- a sub-reflector (8) having convex or concave form;

- a rigid support (9) of material having low loss and relative dielectric constant near that of air, which in turn is fixed in a projecting manner on said primary illuminator and which supports in a projecting manner said sub-reflector (8) so that the latter is aligned axially with said wave guide section (1), with the convex part in front of the circular aperture (2) at an appropriate distance therefrom;

- a flange (3) fixed to the wave guide section (1) in an appropriate position and which couples with a primary reflector (12) of the antenna in the apex thereof and which allows production of said axial support supporting rigidly said illumination system.

9. Antenna illumination system in accordance with claim 8, characterized in that said rigid support (9) has the shape of an at least partly hollow truncated cone and is fixed in a projecting manner by cementing in the terminal part of said wave guide section comprising said circular radiant aperture (2).

10. Antenna illumination system in accordance with claim 8, characterized in that said rigid support (9) has essentially the shape of a hollow cylinder containing said wave guide section (1) up to said flange (3) and is fixed in a projecting manner by cementing on said flange (3) as well as possibly again on said wave guide section (1).

11. Antenna illumination system in accordance with claim 8, characterized in that to provide said axial support, the apex of the primary reflector has a hole whose edge includes a stopper and said flange (3) engages on said stopper from the rear of the primary reflector and is fixed rigidly to said stopper by means of a counter-flange (13).

12. Antenna illumination system in accordance with claim 11, characterized in that said edge including a stopper is provided through an element formed like a circular crown which adapts and is rigidly fixed to the rear part of the primary reflector around the hole made in the apex.

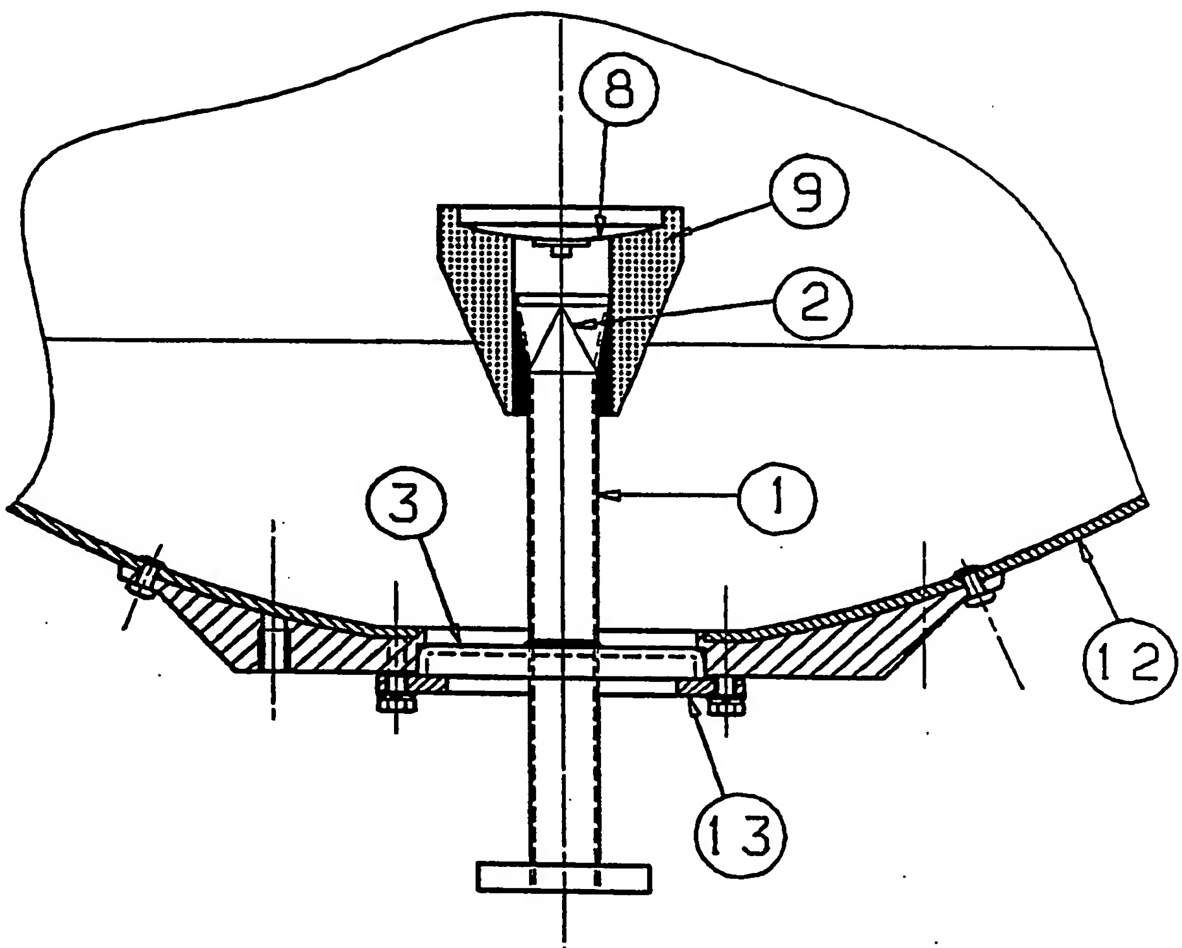


fig. 1

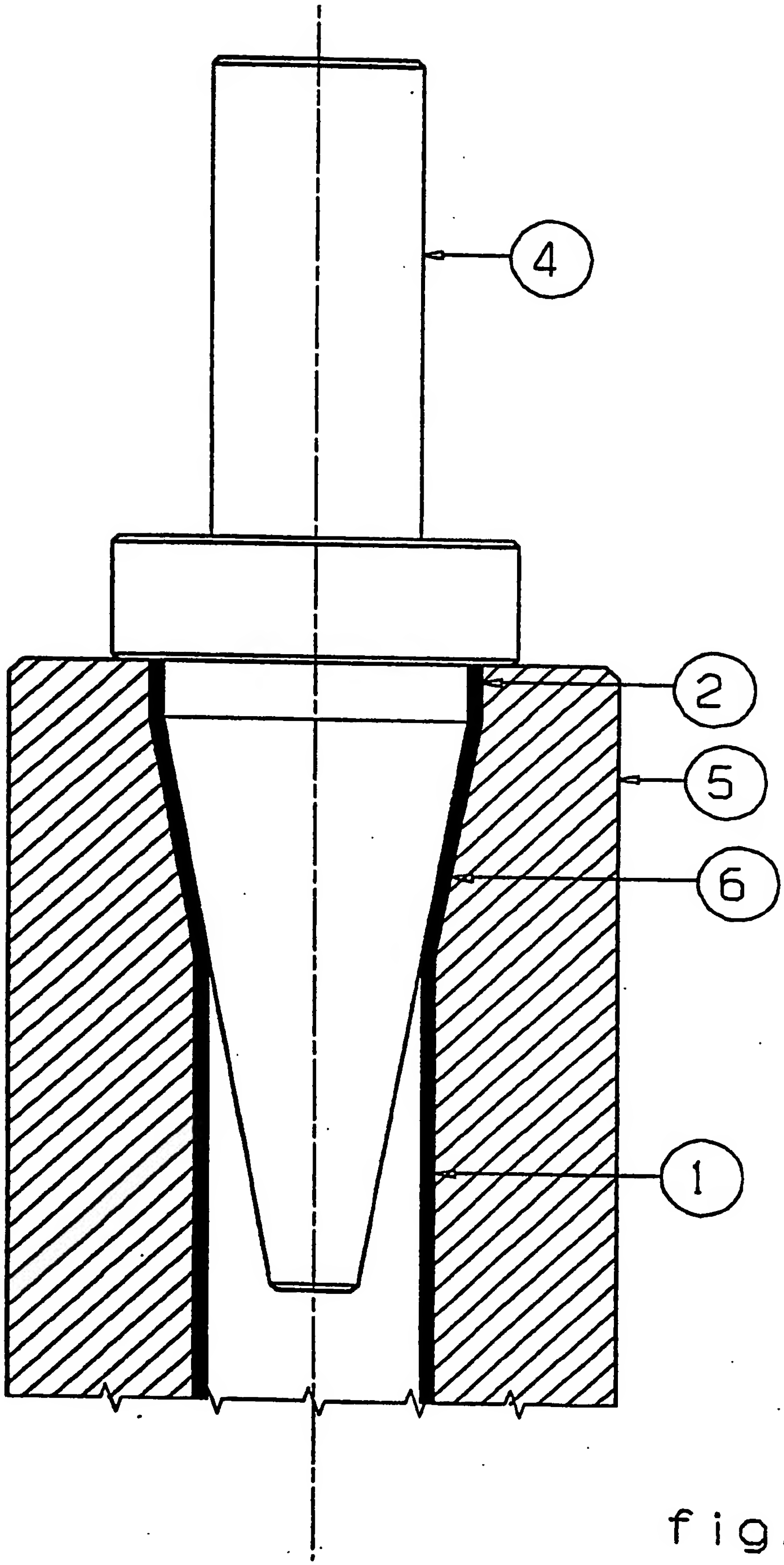


fig. 2

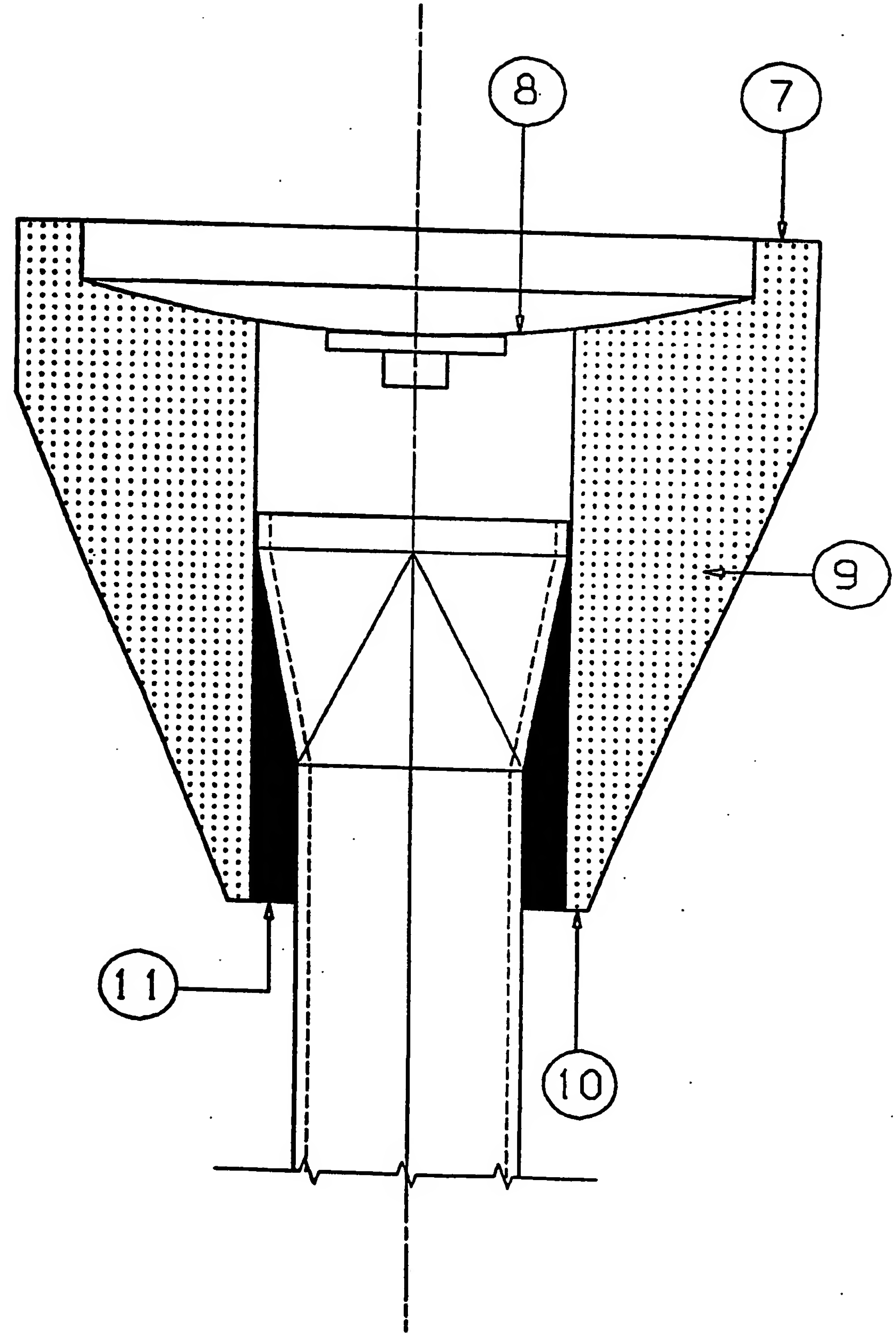


fig. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 96/02201

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01Q19/19 H01Q19/13 H01Q13/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H01Q H01P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE,A,32 31 097 (SIEMENS) 23 February 1984 see page 4, line 34 - page 7, line 33; claims 1-7; figures 1-3	1,2,8
Y	WO,A,86 07197 (LICENTIA TALALMANYOKAT ERTEKESITÖ ES INNOVACIOS KÜLKERESKEDELMI ..(HU)) 4 December 1986	1,2
A	see abstract; figures 1,3	4
Y	FR,A,2 672 435 (COMPAGNIE GENERALE DE TELECOMMUNICATIONS INTERNATIONAL CGTI) 7 August 1992 see claims 1-11; figures 1,3	8
A	DE,A,38 23 056 (SIEMENS) 11 January 1990 see claims 1-7; figure 2	1,2,8

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
5 September 1996	- 8. 10. 96

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 96/02201

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR,A,2 568 415 (LEBBON) 31 January 1986 see claims 1-14; figures 1,3 -----	1,8

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 96/02201

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FR-A-2568415	31-01-86	NONE		